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Research on Ambient-Temperature Passive Magnetic Bearings at the Lawrence Livermore National Laboratory

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Research performed at the Lawrence Livermore National Laboratory on the equilibrium and stability of a new class of ambient-temperature passive magnetic bearing systems will be described. The basic concepts involved are:

(1) It is sufficient if stability of the rotating system is only achieved in the rotating state. That is, centrifugally disengaging mechanical systems can be used to insure stable levitation at rest (when Earnshaw's theorem applies).

(2) Stable levitation by passive magnetic elements, above a low "lift-off" speed, can be achieved if the vector sum of the force derivatives of the several elements of the system is net negative (i.e., restoring) for axial, transverse, and tilt-type perturbations from equilibrium.

To satisfy the requirements of (2), using only permanent magnets to energize the bearing system, at least one non-axially symmetric element must be employed [2]. In order to meet this requirement we have employed periodic "Halbach array" [1] magnets, interacting with passive inductively loaded circuits. Since these elements need act only as stabilizers the losses associated with their use can be made to be very low, with the primary forces arising from axially symmetric permanent-magnet elements. The force derivatives of these latter elements are then tailored to satisfy criterion (2) above.

In our work we have constructed Halbach array and other elements that can be employed to create compact ambient-temperature passive magnetic bearing systems. We have also examined novel passive means for stabilizing classes of rotor-dynamic instabilities in such systems.

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[1] K. Halbach, Nuc. Instruments and Methods, **187**, 109 (1981)

[2] R. F. Post, US Patent 5,495,221, "Dynamically Stable Magnetic Suspension/Bearing System."